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(54) Title: Process for producing dental prostheses

Process for producing dental prostheses

Technical Domain

This invention relates to a process for producing dental prostheses as claimed in the preamble of claims 1 and 14. It also relates to a machining station for producing dental prostheses as claimed in the preamble of claim 15 and a blank as claimed in the preamble of claim 17.

Prior Art

WO 99/47065 discloses a process and a blank for producing artificial crowns and/or bridges which can be matched to a tooth stump which had been prepared beforehand. The three-dimensional outer and inner surface of a positive cast of the base frame for crowns and/or bridges are scanned and digitized. The determined data are linearly increased in all 3-dimensional directions by a factor which compensates exactly for the sintering shrinkage, are transmitted to the control electronics of at least one machine tool for working blanks of porous ceramic, and suitable tool paths are derived from it. By means of control commands for tools the material is removed from the blank, decoupled in time from the digitization, until there is an enlarged embodiment of the positive cast. This enlarged base frame is sintered to the base frame with direct end masses. In doing so powders or colloids for producing the blank are processed by way of known methods of ceramic shaping into green blanks. This publication furthermore emphasizes that for production engineering reasons simple geometrical shapes such as cylinders or cuboids are made available for the blanks. Consequently the teaching for technical action from this publication is based on cylindrical or cuboidal blanks which are pivotally clamped between two shafts. For reasons of production these blanks

have a short length so that they are suited solely to be useful for only a single dental prosthesis consisting of few elements. It is furthermore conspicuous here that machining takes place on the surface perpendicular to the lengthwise axis of these cylindrical or cuboidal blanks; this inevitably leads to extensive removal of ceramic material and wear of the machining tools, especially when the blanks are of cylindrical shape. Furthermore, it is obvious here that the working of these blanks requires longer milling times. These important limitations greatly reduce the acceptance of the technology proposed here.

Description of the Invention

The invention intends to provide a remedy here. The object of the invention as is characterized in the claims is to propose a process which can permanently eliminate all the aforementioned disadvantages. In particular, the object is to suggest a process based on a system which for the first time enables a wide range of dental prostheses with ceramic material, these prostheses being able to be produced by the most simple operation of the hardware and software which belongs to the process at low production costs.

Viewed in this way, the first focus of the invention is to make available a ceramic material which can be worked for dental prostheses, with a configuration which can eliminate the possibilities which limit the prior art. The ceramic material as claimed in the invention consists of a disk-shaped or puck-shaped blank which for its part is obtained from a compact which is formed in fully isostatic or quasi-isostatic pressing.

The blank obtained by fully isostatic or quasi-isostatic pressing is of a cylindrical or quasi-cylindrical shape and has a relatively great length with a relatively large diameter, preferably greater than 50 mm, such that at right angles to its axis a greater

number of disk-shaped blanks of varied thickness can be separated in parallel cutting technology.

In itself, the blank can also consist of a round or quasi-round disk of variable diameter and thickness or of some other geometrical external shape of variable external dimension and thickness.

The fully isostatic pressing is characterized in that the pressure is applied on all sides, i.e. also in the axial direction, to the cylindrical or cylinder-shaped blank, by which a maximized, homogenous internal density of the ceramic material over the entire machining surface is achieved. This high-quality homogeneity has the advantage that the subsequent final sintering process for the dental prostheses which has been produced, independently of the sector of the blank from which they originate, is characterized by exact, predefinable shrinkage; this is reflected in the exact dimensional stability of the final product.

As claimed in the invention, it is furthermore ensured that the disk-shaped blanks before machining into dental prostheses are either in a defined unsintered form, or are first thermally treated according to certain criteria such that they are machined as blanks which have not yet been finally sintered. A homogeneous, defined physical structure of the blanks is the prerequisite for the shrinkage in the final sintering process being exactly fixed beforehand in conjunction with the produced dental prostheses, regardless of whether this final sintering process is conducted up to the absolute specific weight of the ceramic material or is to remain under it, as required.

One important advantage of the invention is that the large area of the blank easily allows accommodation of large dental prostheses which extend up to 14-element bridges, the accommodation of several prostheses at once for machining being possible, so that it is obvious that longer milling operations without material changing is possible

with these blanks. This results in that the retooling time is distributed among a host of prostheses; this highly benefits the production costs of these products.

Another important advantage of the invention is that production costs are further minimized in that the maximized diameter of the blanks allows better use of the material in the arc area such that optimized placement of the machining operations which are to be carried out is possible at any time, even subsequently for an already highly worked blank.

Another important advantage of the invention is that, depending on the prosthesis, different blank thicknesses can be used, for example thin blanks for crowns, thicker blanks for tall bridges.

Another important advantage of the invention is that an exact prediction about the shrinkage which is to be expected in the final sintering process becomes possible by classification of the blanks.

Basically one important advantage of the invention, as already indicated above, is that at this point machining takes place, not on the periphery of the cylindrical or cuboidal blank, but on the plane surfaces of the disk-shaped blank as claimed in the invention, with which for the blanks as claimed in the invention shorter machining times (milling times) result, since less material need be removed compared to cylindrical or cuboidal blanks.

Advantageous and feasible developments of the object as claimed in the invention are identified in the other claims.

One embodiment of the invention is detailed below using the drawings. All elements which are not important to the immediate understanding of the invention have been omitted. The same elements are provided with the same reference numbers in the different figures.

Short description of the Figures

Figure 1 shows the most important features in the working of the blank,

Figure 2 shows the production of dental prostheses from a blank and

Figure 3 shows a 3-element bridge.

Embodiments of the Invention, Commercial Applicability

Figure 1 shows the mechanical disposition in the machining of a blank 3. As already repeatedly described above, this blank 3 has the shape of a disk and is clamped vertically in a holding device 4 within at least one CAD/CAM machining station, with which a spindle traversing motor 1 with the pertinent cutters 2 works the surface of the blank 3 in the horizontal direction. The blank 3 is pivotally clamped in a holding device 4 by way of the axle 5, the blank 3 in the peripheral direction having concentric grooves 6 on which the holding device 4 acts nonpositively. This horizontal machining of the blank 3 is designed such that the occlusal and cavity shapes of the respective dental prosthesis are worked. To do this, the optimum controlled working dispositions are predetermined and implemented. Machining of the blanks can be accomplished not only by CAD/CAM, but also be other cutting systems. The sequences which precede this machining can be briefly described as follows:

The gum is modelled onto the gypsum cast with a plastic material. The intermediate element with the connecting bars (see Figure 3 in this respect) is modelled with wax such that it can be easily removed. The procedure is similar for a bridge with several intermediate elements. First, the modelled gypsum cast is read in with a laser, the data are tailored with software tools, these data then being read into the CAD. Besides the input of wall thickness and cement gap, no other structural interventions are

necessary. Then the holding bars are placed. For a blank with a diameter of roughly 100 mm up to 20 units can be worked (see in this respect Figure 2). The NC milling data are automatically generated. Of course software suitable for this purpose is used and continuously subjected to an improvement process. The entire system easily allows implementation of specific customer wishes. The specifications of the blank as claimed in the invention relating to its production for fully isostatic or quasi-isostatic pressing of a compact and with respect to the unsintered state or the state not finally sintered have already been detailed in the section "Description of the Invention". The compact produced by fully isostatic or quasi-isostatic pressing is externally turned cylindrically as required into a cylindrical solid body before it is cut into blanks in the manner of disks. Of course a CAD/CAM machining station can also be imagined in which the blank is arranged horizontally and the spindle traversing motor then operates vertically.

Figure 2 shows the blank 3 with its free, machinable surface 7, in which milled prostheses 8 as well as bridges and crowns 9 which have already be detached from it are apparent.

Figure 3 shows a machined, 3-element bridge consisting of two end-side crowns 11, an intermediate element 12 and two intermediate connecting bars 13. The bridge is delivered to a final sintering process after it is detached from the blank. In order to ensure optimism process accuracy here, a high temperature tube furnace is used which represents an optimum choice based on its reproducible high accuracy. With an output of more than 4 KW and a reproducible accuracy of +/-2°C this sintering furnace forms the last process step of the production process. Prostheses produced from zirconium oxide are distortion-free at more than 1500°C within 16 hours and are sintered to the absolutely attainable specific weight of 6.075 g/mm^3. If the absolutely attainable specific weight in

the dental prosthesis is not desired for any reason, the temperature and the residence time in the sintering furnace can be matched accordingly.